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OPERATION MANUAL FOR INVENTORY OF PRIVATE FOREST LAND

Phase I Area Determination

**STATE OF MONTANA
Office of State Forester
1958**

**GARETH C. MOON
State Forester**

This Manual As Prepared By The Office Of The State Forester
Has Been Adopted By The Board Of Equalization As The
Manual, Under Which The Forest Inventory Will Be Made,
Pursuant To Chapter 84-429.12, Laws of 1957.

**BOARD OF EQUALIZATION,
By: J. F. REID, CHAIRMAN
E. J. BYRNE, MEMBER
W. J. WINTERS, MEMBER**

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The following are errors noted in the Operation Manual for Inventory of Private Forest Land. Please make these changes in your Manual.

Page 7, Sawtimber: - line 2 - should read, "(see Volume Table P. 8)" rather than, "(see Volume Table P. 12)".

Page 7, Sawtimber: - line 4 - omit phrase - "page 10" as footnote (3) is on this page.

Page 8, third line should read, "note (3) page 7," rather than, "note (3) page 10,".

Page 10, first line should read, "Sawtimber stands" rather than, "Sawmill stands".

Page 10, third line under Examples: should read "LP 8W" rather than, "LP 9W".

Page 12, third line should read, "Classification Table, page 13." rather than, "Classification Table, page 21."

Page 26, Field Checks: - last line - should read, "For procedures see page 11." rather than, "For procedures see page 18."

Page 30, last line on page should read, "(See page 11, for procedures.)" rather than "(See page 18, for procedures.)"

Page 37, first entry under heading Map Symbol of Strata should read, "NF & W", rather than, "NF & """.

FOREWORD

This Operational Manual is designed to assure a uniform and general procedure for the Area Determination phase of this inventory. The method has been designed to be accomplished within the two mill levy, authorized by law. This limitation will affect the desired accuracy through possible reduction of standards. All personnel engaged in any phase of the field or office work of this project are to become familiar with the procedures and definitions set forth in this manual and to follow them at all times. This manual is as complete as possible at the time of publication. Nevertheless, as the project progresses, better techniques may be developed. When these techniques are developed and more information is obtained, additions and revisions to this manual will be made.



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AREA DETERMINATION PHASE

OPERATIONAL MANUAL FOR INVENTORY OF

PRIVATE FOREST LANDS

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INVENTORY PURPOSE

The purpose of this inventory is to provide the various counties of the State of Montana with the forest type areas, accessibility, and the values thereof for all the private forest land within the county by each ownership. This information will be a basis for the County Assessor to evaluate the forest land for tax assessment purposes.

GENERAL PLAN

This inventory is based on the principle of area stratification. An undivided forest area varies so much in its composition that no data may be applied to an individual area, even though that data is the average of the whole. When the forest is delineated into many strata the average of each stratum develops significance for an individual tract of land. With the method explained in this manual it is possible to have as many as 56 separate type strata in E. Montana, (area east of Continental Divide), and 72 separate type strata Western Montana. Each of these type strata has average properties which may be appraised in dollar and cent values for a county or a group of several counties. The determination of the dollar value will be accomplished by the Board of Equalization.

This Inventory of Private Forest Land is divided into the following phases:

- I. Area Determination
- II. Timber Stand Volume Table Preparation
- III. Valuation Table Preparation
- IV. Tax Assessment

Phase I: Area Determination;

This manual covers only the Area Determination Phase, which will be accomplished by the Office of the State Forester. It is divided into the following steps:

1. Forest land area delineation and classification.
2. Field checking area delineation work.
3. Transcribing photo data to base maps.
4. Area Calculation.

Phase II: Timber Stand Volume Table Preparation; will also be accomplished by the Office of the State Forester, involves the following steps:

1. Collection of current reliable Forest Survey and other inventory data.
2. Compilation of Stand Table for county or group of counties.

3. Check for field reliability.
4. Collect additional field data if necessary.
5. Final preparation of Stand Tables.

Phase III: Valuation Table Preparation;

will be accomplished by the Board of Equalization. This table can be determined from pertinent information coupled with the experience of a qualified state official. This type of valuation table would show per acre values of forest land by timber type, size and volume classes as modified by accessibility and topography. Preparation of this valuation table will be controlled by the pertinent specifications and definitions established in the Area Determination and Timber Stand Volume Table Preparation Phases of this Inventory.

Phase IV: Tax Assessment Phase;

will be handled by the County Assessors of the various counties. The steps involved in this phase are:

1. Preparation of a certified ownership unit map and list of forest land owners in the respective county. This map and list will be to the specifications of the Office of the State Forester so that area calculations by owner and each forest classification can be made. It will be necessary to furnish this information to the State Forester before work can be completed under Phase I.
2. Receipt of forest acreage by the various classifications for each ownership from the Office of the State Forester.
3. Receipt of valuation Table from the Board of Equalization.
4. Tax Assessment.

Operational Manuals for Phases II, III, and IV may be prepared, where necessary, under separate cover, by the agency responsible.

DEFINITIONS AND SPECIFICATIONS

General

In order to capture the maximum benefits from the technical work already accomplished by other agencies, certain definitions and specifications must be adhered to exactly. The definitions and specifications which will be used in the field may be obtained from the manual "Field Instructions for Forest Inventory—Rocky Mountain Area."¹ Certain definitions and specifications that pertain to Area Delineation have been extracted here and will be used in the phases of this inventory.

¹ May be obtained from Director, Intermountain Forest & Range Experiment Station, U. S. Forest Service, Ogden, Utah.

Breast Height

Breast height for this survey is defined as being 4½ feet above **mean** ground level.

Log Height

The number of 16-foot sawlogs in sawtimber trees to the merchantable top, rounded to the nearest log. Where the top is broken out the log height should be estimated to where the merchantable top would have been and a deduction made for cull.

Merchantable Top

The point on the bole of a sawtimber tree coinciding with the minimum diameter inside bark for a merchantable sawlog. Top diameters will vary with the DBH of the tree as listed below:

DBH (inches)	Top DIB (inches)
10, 11	5
12, 13, 14, 15	6
16, 17, 18	7
19, 20, 21	8
22, 23, 24, 25	9
26+	10

Tops vary by diameter classes and are more precisely defined as follows: $\text{Top dib} = .3\text{dbh} + 2.0$ with 10.0 inch maximum.

Merchantable Trees

Live sound trees which meet the following specifications:

Sawtimber trees—Live sawtimber trees containing at least one 10-foot log to a merchantable top DIB and having one-third or more of their gross board-foot volume in sound merchantable material and which are likely to eventually contain at least a 16-foot minimum sawlog. Trees which contain a sawlog 10 feet long or longer but which are so girdled, gnarled, broomed out, or otherwise injured or deformed as to make it unlikely that they will ever contain a 16-foot sawlog will not be called merchantable.

Poletimber trees—Live poletimber trees which are likely to grow into sound merchantable sawtimber trees. Pole trees with rot will not be called merchantable.

Sawlog

A minimum sawlog must be 16 feet long to a minimum top DIB of 5 inches and must have one-third or more of its gross board foot volume in sound merchantable material. (EXCEPTION: For 1-log sawtimber trees the minimum sawlog shall be 10 feet long in judging merchantability class.)

Tree Size

Sawtimber trees—Trees 11.0 inches DBH and larger.

Pole trees—Tree 5.0 inches to, but not including 11.0 inches DBH.

Seedling-Sapling trees—Trees well established to, but not including 5.0 inches DBH.

DBH or dbh or Diameter Breast High

The diameter of the tree at 4½ feet above average ground level, outside the bark unless otherwise stated.

DIB or dib or Diameter inside bark

The diameter of the tree measured inside the bark.

Land Use Classes

Nonforest land: Land that does not qualify as forest land. Includes land which has never supported forest growth; land from which the forest has been removed to less than 10 percent stocking and has been developed for other uses, such as grazing, agricultural, residential, or industrial; all land in thickly populated urban or suburban areas, and water classified by the Bureau of Census as land. Roads, streams, canals, right-of-way, clearings and treeless strips within the forest zone must be at least 120 feet wide to qualify as nonforest land. The minimum area is 5 acres. Nonforest land within the forested zone will be designated by "W" for water which is classified as land, or "NF" for all other nonforest land. This inventory will not be a basis for the appraisal of nonforest land. Its area will be computed only as a means of determining the forest land area.

Forest land: Includes (a) lands which are at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime, (b) land from which the trees described in (a) have been removed to less than 10 percent stocking, but which has not been developed for other use; (c) afforested areas; and (d) chaparral areas which have a crown closure of 50 percent or more. The minimum area for classifying forest and nonforest is 5 acres. Stringer types must be at least 120 feet wide, regardless of

length, in order to qualify as forest land. In addition, roads, streams, canals, rights-of-way, clearings and treeless strips within the forest, but less than 120 feet wide are also considered forest land. All forest land will be classified further as commercial or non-commercial according to the specifications set forth under those categories.

Noncommercial Forest Land: Two general kinds of noncommercial forest land are recognized; productive and nonproductive:

Productive—Public forest land withdrawn from timber utilization through statute, ordinance, or administrative order, but which otherwise qualifies as commercial forest land (Example: Glacier Park). It is not anticipated that any of the private land involved in this inventory can be classified as Productive Noncommercial Forest Land, but if any is encountered it will be subdivided into the same forest types, stand-size classes, and stocking classes as commercial forest land and appraisal differences will be determined by the County Assessor.

Unproductive—Forest land incapable of yielding usable wood products (usually sawtimber) because of adverse site conditions, or so physically inaccessible as to be unavailable economically now or prospectively. All unproductive noncommercial forest land will be so classified and labeled with the map symbol "NC." This land will be also classified as unproductive as far as accessibility and topography class is concerned.

Each area under consideration must be judged separately on its own characteristics. Field men will visit local cutting operations to obtain a gauge of the kind of forest land being cut over today by commercial operators. A fairly safe assumption is that stands similar to those being cut are operable under present economic and technologic conditions and are therefore in the category of commercial forest land. There are, however, exceptions even to this. Fieldmen should seek decisions on particular forest areas and use these case examples when judging areas in the future.

As aids in recognizing noncommercial forest lands, the following examples may be used:

1. Small blocks of forest land that are completely surrounded by terrain that prohibits harvesting, economically, are non-commercial. They are also called unproductive from an economic standpoint (accessibility and topography). To be called commercial the block of timber must be large enough and have species of sufficient value to stand the cost of road construction or installation of a Wyssen or some other system of cable logging. Remoteness alone is not an acceptable reason for calling an area noncommercial since immediate history and present planning indicate that roads will be built or new and cheaper methods of logging and

transportation will be developed which will make presently remote areas economic to operate in the immediate future. Classification according to Accessibility and Topography will allow for the differences in the relative value of the area.

2. Tree size caused by the young age of the stand should not be considered in classifying noncommercial from commercial forest land. The trees on commercial forest land will grow and become merchantable.
3. There are areas producing good individual trees but are so strewn with boulders or cliffs that logging is impossible. Such areas are noncommercial.
4. Other areas do not have the soil, water, weather, aspect and other factors needed for growing usable sawtimber; these are probably the easiest to recognize. The timber is short, scrubby, slow growing, and few, if any, of the stems will make a sawlog. These forest areas are quite often at high elevations. They may be extremely valuable for watershed, grazing, or other purposes. They will be classified as noncommercial forest land.

Commercial Forest Land: Forest land which is (a) producing, or physically capable of producing usable crops of wood (usually sawtimber); (b) economically available now or prospectively; and (c) not withdrawn from timber utilization. All commercial forest land will be subdivided into the cover types, stand-size classes and stocking classes as explained in this manual.

Forest Type Classes

Basis for Classification—The species having the predominance of cubic-foot volume of sawtimber trees in sawtimber stands, pole-trees in poletimber stands, or number of stems in seedling-sapling stands will determine the type designation. Where no species comprises 50 percent or more of the stand, the stand should be typed on the basis of the plurality of cubic foot volume or number of trees. For example, a stand having 55 percent of its cubic-foot volume in Douglas-fir trees would be typed as Douglas-fir. A stand having 40 percent of its cubic foot volume in ponderosa pine, 30 percent in Douglas-fir, 15 percent in lodgepole pine, and 15 percent in white fir would be typed as ponderosa pine.

Cover Type Classes

Species	Map Symbol
Western white pine.....	WP
Ponderosa pine	P
Western larch (*1) (*2).....	L
Douglas fir (*1).....	D
Englemann spruce, white spruce.....	S
Lodgepole pine (*3).....	LP
Western hemlock (*2).....	WH
Grand fir, alpine fir, white fir, (True Firs).....	TF
Western Red Cedar.....	C
Cottonwood	Co
Willow, aspen, birch, and other hardwoods	OH
Whitebark pine, limber pine.....	WLP

Stand-Size Classes

Sawtimber: Stands with a minimum net volume per acre of 1,500 board feet, International $\frac{1}{4}$ -inch rule (see Volume Table P.12), in trees of sawtimber size (11.0"+dbh). Map symbol 9. (see footnote (3) page 10, pertaining to lodgepole pine.)

Poletimber: Stands failing to meet the sawtimber stand specifications, but at least 10 percent stocked with poletimber and larger (5.0 inches dbh and larger) trees and with at least half the minimum stocking, or 5 percent, in poletimber trees (5.0 inches to, but not including, 11.0 inches dbh). Stands which are 10 percent, or more, stocked with sawtimber and poletimber trees, but less than 1,500 net board feet per acre Int. $\frac{1}{4}$ -inch rule and with few or no poletimber trees will not be classed as poletimber areas. Such areas will be classed as

-
- (1) In certain stands in Western Montana the fir and larch are approximately in equal proportion. Such stands may be typed as Douglas Fir and larch with the map symbol "DL".
 - (2) High elevation species such as alpine larch and mountain hemlock rarely form a merchantable tree, but if such trees are found in a merchantable form they are to be included with their commonly commercial relative. In the majority of cases, such stands will be classed as unproductive noncommercial forests.
 - (3) Since the average diameter of a mature lodgepole pine stand, both in Eastern and Western Montana, is approximately 11.0" dbh in most cases, this species will not be divided between poles and sawtimber, but will be classed: poles, or better, with the map symbol of "LP 8".

either seedling-sapling or nonstocked, according to the definition of these classes. Poletimber map symbol is 8. (see footnote (3) page 10, pertaining to lodgepole pine.)

Seedling-Sapling: Stands not qualifying as either sawtimber or poletimber stands, but having at least 10 percent stocking of trees of commercial species and with at least half the minimum stocking, or 5 percent, in seedling-sapling trees (well established to, but not including, 5.0 inches dbh). Map symbol is 7 for seedling-sapling stands.

Nonstocked and Deforested: Areas not qualifying as sawtimber, poletimber, or seedling-sapling stands, i.e., normally less than 10 percent stocked. May in some cases include areas more than 10 percent stocked, e.g., stands more than 10 percent stocked with sawtimber trees, but with insufficient board foot volume to qualify as sawtimber stands. Map symbol 6. Nonstocked and deforested areas will be classified by the latest forest type which last occupied the area.

VOLUME PER ACRE REPRESENTED BY ONE TREE ON A 1/5-ACRE PLOT International 1/4-Inch Scale

DBH Class	Height in feet						
	40	50	60	70	80	90	100
Board Feet (INT. ¼-Inch)							
12	280	390	505	620	735	850	945
14	390	545	715	860	1000	1155	1290
16	505	715	910	1100	1290	1485	1680
18	590	850	1110	1360	1605	1860	2105
20		1025	1320	1620	1915	2215	2515
22		1400	1735	2165	2550	2940	3315
24			2030	2475	2910	3350	3785
26					3275	3885	4300
28					3595	4180	4665
30					3865	4530	5180

To be used by fieldmen as a guide for gauging whether or not borderline stands should be classed as sawtimber stands—1,500 + board feet per acre in sawtimber trees.

That is, in poorly stocked stands a fieldman can readily determine if one or more of the required trees are on a $1/5$ acre. If not, the plot is considered non-stocked. After a given sample of the area is taken, a quantitative measure will definitely show in what stocking category the area in question lies.

Stocking Classes: Stocking is the extent to which growing space is effectively utilized by present or potential growing stock trees of commercial species. Stocking may be measured in terms of number of trees, volume, basal area, crown cover, or other criteria or combination of criteria. In the area covered by this manual, sawtimber stands will be classed as to stocking on a dual crown cover basis. Poletimber and seedling-sapling stands will be classed as to stocking on the basis of crown closure of all trees, except where the crowns of the trees are too small to be seen on aerial photographs, in which case the number of trees, as determined by ground check, will be the basis for estimating stock class.

The following table is to be used as a guide by fieldmen to determine stocking classes in stands where trees are too small in crown diameter to register on the aerial photos.

Minimum Number of Seedling and Sapling Trees on a 1/500 Acre Plot (Radius=5.26 feet) by Stocking Classes

Seedling-Sapling Size	Stocking Class		
	Well	Medium	Poor
Well established through .99" dbh.....	5	3	1
1.0" dbh through 2.99" dbh.....	3	2	1
3.0" dbh through 4.99" dbh.....	2	1	..

Crown Closure Specifications (or number of trees)

Sawtimber Stands, Poletimber Stands, and Visible Seedling-Sapling Stands:	Map Symbol
Nonstocked—0-9 percent stocked.....	(none)
Poorly stocked—10-39 percent.....	P
Medium stocked—40-69 percent.....	M
Well stocked—70+ percent	W

Sawmill stands will have a dual classification; (1) crown density by all trees and (2) crown density by sawtimber trees only.

Examples: P 9 WM—Ponderosa pine, sawtimber, well stocked by all trees, medium stocked by sawtimber trees.
 LP 9 W—Lodgepole pine, poletimber or better stand, well stocked by all trees.
 TF 7 W—Alpine fir (true firs) seedling-sapling stand, well stocked by all trees.

Condensed Map Classes And Symbols

Commercial Forest Land Classes Cover Type	Map Symbol
---	------------

Western white pine.....	WP
Ponderosa pine	P
Western larch	L
Douglas fir	D
Douglas fir and western larch.....	DL
Englemann spruce, white spruce.....	S
Lodgepole pine	LP
Western hemlock	WH
Grand fir, alpine fir, white fir (true firs).....	TF
Western red cedar	C
White bark pine, limber pine.....	WLP
Cottonwoods	Co
Willow, aspen, birch and other hardwoods.....	OH

Stand-Size

Sawtimber stands*	9
Pole Timber Stands*.....	8
Seedling-Sapling stands	7
Nonstocked and deforested stands.....	6

Stocking (Crown density or number of trees)

Poorly stocked 10-39%	P
Medium stocked 40-69%.....	M
Well stocked 70+%.....	W

(In dual classification of sawtimber stands, stocking class for all trees is followed by stocking class by sawtimber trees only.)

Activity since Photography.....A

Non-Commercial Forest Land.....NC

Non-Forest Land

Water, classified as land, generally less than 40 acres..	W
Other	NF

*See footnote (3) page 7, pertaining to lodgepole pine.

Minimum Area

Minimum area is the smallest forest type that is delineated by the foregoing classes. Five acres is the minimum area for contrasting conditions, while ten acres is the minimum area for non-contrasting conditions. Roads, streams, canals, rights-of-way, clearings and treeless strips in forested area; and stringers of timber in non-forest areas must be over 120 feet in width, regardless of length, to be delineated from the surrounding class. Although it may be possible to recognize smaller areas on the photographs, drafting limitations, area compilation techniques, and availability of field data dictate that this limit be established.

Contrasting Conditions

Contrasting conditions which will be delineated to a minimum area of 5 acres are:

- (1) Forest versus non-forest.
- (2) Commercial forest versus non-commercial forest.
- (3) Softwoods versus hardwoods.
- (4) One stand-size class to another two steps removed, e.g. poles versus obviously large sawtimber, seedling-sapling versus sawtimber, nonstocked versus polestands.
- (5) One density class to another two steps removed, e.g. poorly stocked versus well stocked.
- (6) Areas differing by one step in two or more items of the stratum designation, e.g. P 9 WM versus P 8 M, or S 8 W versus S 7 M.

Non-Contrasting Conditions

Non-contrasting conditions which will be delineated to a minimum area of 10 acres are:

- (1) All cover types (excepting softwoods versus hardwoods).
- (2) One stand-size class to another one step removed, e.g., poles versus sawtimber.
- (3) One stocking class to another one step removed, e.g. medium stocking versus well stocked.

Access and Topography Classes

Procedures for Classification: Access and topography classes will be determined for each 40 acre tract of land. Each grade in the various divisions of this classification will be the average for the 40 acre tract. The class of accessibility and topography will be

determined by the numerical sum of the various average grades in the divisions for the tract. For specifications of each class see Classification Table, page 21.

Prior to entering the field for the field check of forest type strata, the fieldman will prepare, or have prepared, copies of

Access and Topography Field Classification Form (see page 14)

completed except for collection of field data. Planimetric features will be transferred from the base map to this form by use of the "Overhead Projector."

While in the field the fieldman will classify each 40 acre tract, labeling in the center of the appropriate tract on the form, the grade average to that tract. Use red pencil for Road Development Characteristics to the Tract grades. Use blue pencil for Topography on the Tract grades. Only if the average grade of a $\frac{1}{4}$ section or a section is identical for every forty within the $\frac{1}{4}$ section or section will the grade be placed in the center of the larger area. If a definite line separates two grades, a line will be drawn in the color appropriate for that division, at the approximate location of this grade change. Remarks may be entered to clarify the classification, if necessary. Remarks will not be used if they would confuse the operator who will transcribe this information to the base map; decisions will be made in the field.

Determination of grade under Distance from Manufacturing Point will be made at the time this information is transferred to the base map and the area is calculated. Use will be made of a map showing areas within the various distances from appropriate manufacturing points.

During the transcribing and area calculation processes the operator will make every effort possible (field classification form combined with photo interpretation) to assure that an ownership smaller than 40 acres which might lie in more than one forty be classified as to the average of the smaller tract.

ACCESS AND TOPOGRAPHY CLASSIFICATION TABLE

Access and Topography	Road Development Characteristic to Tract	Topography on Tract	Distance from Manufacturing Point**	Total Grade in Class*
FAVORABLE	Grade R-1 Tract within 1 mile of usable road. Easy Road construction. No rock outcrops or swamp barriers.	Grade T-1 Flat to gentle Slopes generally under 40%. No rock outcrops or swamps. Good tractor logging grd.	Grade D-1 Less than 25 miles	3 and 4
	Grade R-2 Tract 1 to 3 miles from usable road. No difficult road problems. Average construction.	Grade T-2 Variable slopes under 60%. Some rock outcrop or swampy ground. Average logging conditions.	Grade D-2 25 to 50 miles	5, 6 and 7
DIFFICULT	Grade R-3 Tract 3 to 6 miles from usable road. Also includes tracts closer, but with difficult construction problems such as rock or water barriers and rough terrain.	Grade T-3 Rough, broken ground. Steep slopes. Numerous rock outcrops and bluffs or other features which make logging difficult.	Grade D-3 50 to 100 miles	8 and 9
IMPRACTICAL	Grade R-4 Tract over 6 miles from usable road.	Grade T-3 (Same as above)	Grade D-4 Over 100 miles	10 and 11
UNPRODUCTIVE	Any one of the following factors will place the tract into this class: Extreme physical barriers preventing accessibility. Extreme low grade of land and timber. (See specifications for unproductive noncommercial forest land) If legal barriers, (Rights of way, etc.) or reservations for recreation, watershed or other use which will prevent logging for an indefinite period do exist, determination will be made by the County Assessors.			

*Class of Accessibility and Topography is determined by the sum of the numerical values of the grade average to tract in each of the divisions of this classification.

**Manufacturing Point is defined as a sawmill with planer on a railroad or the equivalent.

Access and Topography Field Classification Form

.....County
Sec..... Twn..... Rge.....
Photo No.....

Remarks:
.....
.....
.....
.....
.....

Prepared by..... Date.....
Field Classified by.....
Date.....

PHOTO DELINEATION PROCEDURES

Aerial Photo Preparation

Photo Indexes

Aerial photography may include projects flown for the Forest Service, Soil Conservation Service, Commodity Stabilization Service, and occasionally others. Complete coverage by photo index sheets will be obtained. On these index sheets large areas of non-forest land will be blocked out as non-forest zone and eliminated from the inventory. On the area retained as forest zone large areas of non-private land will be eliminated also.

Photo Orders

List photos needed by county, project symbol, roll and photo numbers. This initial listing will serve as a guide in sorting and filing the photos when they are received. The photo orders should include:

1. Agency, project and contract number.
2. All photos ordered should be identified by project symbol, roll number, inclusive print numbers and the total prints per roll and per order.

Preparation of Contact Prints

On receipt of a photo shipment the print numbers should be checked against a copy of the order. All photos should then be trimmed, sorted by counties and flight lines. The photos will be labeled on the reverse side with the county name and the progress identification stamp. Locate the center of photo and mark with circle .1 inch diameter using a drop compass and Post's Violet Drawing Ink. The center of the photo is located at the intersection of the fiducial marks.

Care of Aerial Photographs

As there is considerable money invested in aerial photographs, care must be exercised in filing and the use of photographs. They are best filed vertically by counties in 9½ x 11¾ inch expansion type file pockets or by flights within the county in Pendaflex hanging folders. Care must be exercised in keeping photos consecutively by picture numbers within the file pocket.

It should be remembered that photographs are to be used, and there should be no hesitancy in their use in the field. They should, of course, be carefully protected from the weather and other damage.

All temporary marks can be made with china pencil, grease pencil, or a soft lead pencil. These temporary marks can be removed with carbon tetrachloride. A somewhat more permanent

type of marking medium that can be used with a fountain pen or a rapidograph pen and still removed with a damp cloth is Weber's pigment ink. Since this ink is subject to moisture, care should be taken to prevent the photographs from becoming damp or wet. Colors to use are red for cover type, cadmium yellow for cultural features, and blue for drainage features. When inking photographs, powder will improve inking qualities, and a pen with a medium point, like the No. 1 rapidograph, used with a light touch will prevent scratching photographs. Permanent marks can be applied to the photographs with drafting ink using drafting instruments.

Stereoscopy

Before real use can be made of the photographs, it is essential to master the ability to see the photos stereoscopically, or in third dimension. Much information can, however, be gotten from single photographs. Stereovision is obtained by seeing the same object from two angles at the same time. It is through the use of stereovision that things are seen in three dimensions or that objects appear to have depth. The degree of depth perception depends on the angle at which the two lines of sight converge on the same object—the greater the angle, the better the depth perception. Since a person's eyes are a fixed distance apart, the angle at which the lines of sight from his eyes converge on any object decreases as the distance to the object increases. The ability to see depth, therefore, decreases with distance. Binoculars increase depth perception because the system of prisms used increases the angle between the lines of sight. As was stated previously, to get stereovision, it is necessary to look at the same object from two different angles; because of this stereoscopic effect cannot be obtained from two photos taken from the same point or made from the same negative. Two pictures taken from different angles must be used. Any pair of overlapping photos which permits stereoscopic viewing is known as a stereo pair, and any set of three overlapping photos so arranged as to provide complete stereoscopic coverage for the area of the central photograph is termed a stereo triplet. It is in this area of overlap, both end and sidelap, where the stereo effect is obtained. In most instances, stereo pairs or triplets will consist of 2 or 3 consecutive pictures in the same flight line.

In order to facilitate stereoscopic examination of photos, an instrument known as the stereoscope is commonly used. With practice, however, most people can learn to see stereo without the aid of a stereoscope. There are two main types of stereoscopes, the refraction or lens type, and the reflection or mirror type. Each of these has its advantages and disadvantages and there are many styles of each type.

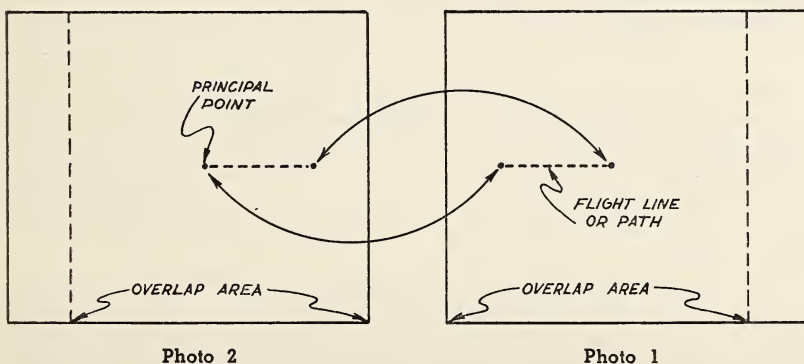
The lens type stereoscope is the simpler of the two and consists primarily of two matched lenses separated by a distance corresponding to that between the eyes and mounted on a suit-

able support. The lenses magnify normally from 1.25 to 4 diameters. For forestry use, 2 to 2½ power is most satisfactory. The lens type of stereoscope is most useful in detailed examinations and in cover type delineations. It is very portable and several pocket models are available at low cost.

The mirror type stereoscope consists of four mirrors set at angles of 45 degrees to the plane of the photos. Lenses are often incorporated in the design of the instrument. The mirror type stereoscope is very useful for effective area delineation, which will be discussed in detail later, because of the large field of view resulting from a reduction in scale. With a mirror type stereoscope, the entire overlap can normally be seen in stereo, and the photos are separated by several inches for stereoscopic examination. In using the lens type, the photos overlap one another, but relief is better defined and detail is more easily studied because of the magnification. For all around use, the lens type stereoscope is probably preferable. The best course is to have either type available.

For proper stereoscopic vision, the two photos of a stereo pair should be oriented in the same direction and in their proper position with respect to each other. The photos should be placed so that the shadows fall as nearly as possible toward the observer. Proper orientation of the photographs is essential to comfortable stereoscopic examination of the overlap area. To properly orient photographs the flight path of the airplane should be placed on the photos. This is done as follows:

1. Mark the principal point, using the accepted method, on one photo of the pair. Use a grease pencil or soft colored lead pencil.
2. Locate this point on the overlap area of the other photo of the pair and mark it. In this position, it is known as the conjugate principal point.
3. Locate the principal point on the second photo, mark it, and locate this point on the first photo, and mark it.



The appearance of the photos is as shown in the above sketch.

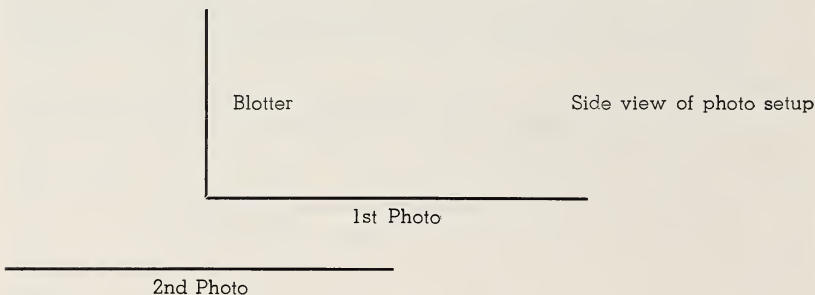
Connect the two points on each photo. This line is the path followed by the airplane between the exposures of the two pictures.

Now superimpose the flight lines and, looking through the stereoscope, with the axis of the stereoscope parallel to the flight line, pull the photos apart, keeping the lines of flight superimposed. Separation distance will be around two inches, but may vary for lens type stereoscopes and with individuals. For mirror type stereoscopes, the photos will be completely separated by about 3 or 4 inches. At the proper separation distance, depending on the individual, and if the work is done correctly, the stereo effect will be obtained. With practice, shortcuts to this procedure will suggest themselves.

It is possible to see stereoscopically without the use of a stereoscope. In many forestry uses, ability to see stereo without use of a stereoscope is invaluable.

In order to see stereo without using a stereoscope, a person must train his eyes to focus on two different photos at the same time, and the images are fused in his mind, thus giving him stereo vision. It is somewhat difficult to do this as it is normal for eyes to converge as their focus is shortened.

There are several ways of training eyes to see stereoscopically. One method is to stand a blotter or similar sheet of paper upright along the edge of one photo along the overlap area. (Use photos having line of flight shown as mentioned above.) The sketch below shows this:



Have the photos separated about one inch along their superimposed flight path, look at the photos so that the blotter is between the eyes; thus the left eye can see only the left photo and the right eye the right photo. By shifting the separation distance along the superimposed flight line back and forth to the correct distance, the individual images should fuse into a three-dimensional image.

This same effect can be accomplished without the use of a barrier by focusing the eyes on a distant object. They are then looking in nearly parallel directions. If a properly oriented stereo pair of photos is quickly inserted in the field of vision, each eye tends to focus upon the photo on its side and the stereoscopic

vision may be attained. The trick is to keep the eyes parallel and yet shorten their focus. Considerable practice may be required to do this easily.

The same effect can be achieved using the fingers. Place the tips of the index fingers together so that the two fingers form a straight line. Hold them in this manner in front of the nose. Raise them to the field of vision and now see the fingers about 1½ to 2 inches apart with a sausage-shaped object between them. This sausage-shaped object is another view of the fingers. This middle figure is stereoscopic, looking at the right finger with the right eye and at the left finger with the left eye. Slowly move the fingers away, keeping the tips together, and see how far away the eyes converge and that middle sausage is lost. Practice at this. It will help in training eyes to see parallel at a short focusing distance. Continued practice is necessary both with and without the use of the stereoscope for seeing stereo until the observer becomes proficient.

As a person masters the ability to see stereoscopically, he can begin to study the photos and determine what can be seen. There are very definite limitations to the information obtainable from pictures. Many types of information require ground checking to ascertain whether or not the proper deductions have been made from study of the photograph. For example, a person can draw type lines on the pictures between some types of vegetation and between stands of different density and different broad age classes. He can measure the height of individual trees under certain conditions. He can generally designate timber type, but he cannot measure volume, either total or by species from the photos alone. That requires on-the-ground sampling. By classifying similar cover types on the photos and determining the area of each condition, the number of samples necessary to get the required information within the allowable limits of error can be determined.

The size and shape of areas outlined on an aerial photo may differ markedly from the actual because of distortion due to relief displacement and other things. One cannot bring out anything in the picture that isn't on the negative no matter how much the photo is enlarged. However, a limited amount of magnification is of help in picking out details.

General Characteristics of Photographs

Photographic images are generally identified on the basis of five elements:

1. Shape and size
2. Color and tone
3. Texture
4. Image pattern
5. Field experience with images

Objects may be identified by one of these elements but usually the interpreter must use all or several to make his identification. The stereoscope should be used at all times during the interpretive process.

Shape and Size

Shape refers to the general form, silhouette, or outline of an object. Tree crowns appear round, ovoid, or pointed when viewed from above, but appear elliptical when viewed obliquely on the margin of the photo. Shapes and shadows are an excellent clue to tree species. For example, spruce and alpine fir have slender, pointed shadows; cottonwood has a rounded shadow. However, it should be remembered that shadows are grossly exaggerated by slope, either by elongating the shadow so it appears long and slender, or by shortening it and making it appear short and stubby, depending upon whether the shadow falls downhill or uphill.

Size relates to the surface or volume dimensions of an object. Trees appear big or small, tall or short, depending on their size. While the visual photographic shape and size of an object is related to its actual size and shape, this relationship is modified by scale and distortion or displacement. Scale changes within a single photo are seldom perceptible, except in those cases where extreme elevation changes of 2,000-3,000 feet occur. However, elevation can frequently change 3,000-4,000 feet over a long flight of photos. In this case, changes are cumulative, and a gradual scale change takes place. An elevation change of 3,000 feet would produce a 30 percent difference in the apparent height of trees of equal size viewed at the extremes of the elevation on photos of 1:20,000 scale.

Objects viewed on the margin of the photo are seen more or less from a side view, rather than the top view near the photo center. Trees seen on the margin may seem to be taller than those near the center because of this difference in view. The interpreter should be careful not to let this difference influence his ideas of stand size.

Some objects are not large enough to be seen on photos with the magnification of the ordinary stereoscope. As a general rule, trees with a crown diameter of less than three feet cannot be seen on photos of 1:20,000 scale. However, lineal objects of smaller size such as railroad tracks, white lines on highways with a black surface, and down snags may occasionally be seen. This should not be assumed to be a scale change. For some reason, very distinct lineal objects may be sometimes seen where other objects, such as trees of small diameter, are not visible.

Since objects less than 3 feet in diameter are not visible at a scale of 1:20,000 it is usually assumed that the portion of the tree crown less than 3 feet in diameter is not visible for height measurement. Trees whose total crown width is less than 3 feet may not be seen at all. Thus, in very small, poorly stocked seedling stands, many of the trees may not be visible.

Height perception of objects less than 10 feet high is often difficult on photos of 1:20,000 scale, even when the crowns are large enough to be seen. Thus brush may appear as grass except for a coarser texture. In the case of relatively short trees, shadows are the best indicator of height. Sometimes shadows of objects can be seen when the objects themselves cannot be distinguished.

Color and Tone of Images

Photographs are black and white. Between these extremes are varying shades or tones of gray, depending upon the degree to which objects reflect light. Dark objects reflect little light and therefore photograph dark. Light objects reflect considerable light therefore photograph light in color. Consequently the same difference in foliage colors that aid species identification on the ground are reflected as tonal differences on photographs. For example, the light green of aspen, the medium yellow green of lodgepole pine, and the very dark green of spruce are represented on photos by tones of gray varying from very light gray of aspen to the very dark gray of spruce. During the fall, when western larch foliage is yellow, larch has a very light tone, almost the same as grass.

Tone is influenced by season, time of day, shadow, development of print, position of the object in relation to the photo center, slope, and site. Season and time of day affect the quality and direction of reflected light and the amount of shadow. Timber stands photographed at noon have very little shadow and have a corresponding lighter tone. Timber stands photographed either before or after noon have longer shadows and timber stands will appear to have a darker tone.

Most aerial photos are contact prints, except in some cases enlargements might be used. The skill of the printer and the type of paper will determine the overall tone of the photos. Overexposed prints have tones in the darker range, while underexposed prints appear much lighter. These unusual prints should be compared with average tone of other photos in the flight so that the odd tones do not influence the interpretation impressions of species or density.

Objects on the extreme margin of the photograph tend to be darker because of the poorer light-gathering qualities of the lens in that area.

South slopes usually appear lighter than north slopes. This is frequently due to less vegetation on the south slope. The north slope usually shows greater amounts of shadow and also reflects less light than a south slope. Moist sites usually photograph darker than dry sites. Thus swampy meadow seems darker than a dry grassland. This is due to the more lush, darker green vegetation in the moist site and frequently some surface water. Water itself usually photographs very dark or black, except in a particu-

lar situation when the sun is reflected off the body of water at just the right angle with respect to the camera. In this case water photographs white, or may even show cloud formations.

Texture

Texture is a term used to describe the apparent degree of fineness or coarseness of the features seen on the photo. On photos of 1:20,000 scale, texture is used to describe the appearance of stands of timber, since individual tree crowns are too small to display visible textures. Thus the texture of a timber stand is the product of the size, shade, shadow, and arrangement of the crown within the stand. The texture of timber stands is analogous to a sheet of sandpaper. A piece of sandpaper with small-sized grit would be finer texture (and smoother to the touch) than another piece of sandpaper with very large pieces of grit. A dense, small-crowned stand of lodgepole pine would appear to have a finer texture than a stand of mature, large-crowned uneven-storied spruce.

Size and arrangement of the crowns within a timber stand affect texture the most. A very dense stand of poles would have a finer texture than an open-grown pole stand. Thus, as the size of the individual crowns increases, the texture of the stand tends to become coarser. Shadows often obscure smaller crowns and give the impression that the larger crowns are more widely spaced. Stands viewed obliquely appear coarser than stands viewed from above.

Comparative textures of some objects:

Very fine—water, grass pastures, cultivated fields.

Fine—very dense stands of brush, aspen, or conifer reproduction.

Medium—mixed stands of poles and saplings, small-crowned sawtimber.

Coarse—mature sawtimber of medium density.

Very coarse—overmature timber with or without an understory of poles and small sawtimber, or partially cut stands.

Image Pattern

Pattern regularity often indicates the efforts of man. Cutting lines, right-of-way clearings, plantations, and fence lines are examples.

Field Experience With Images

The interpreter will usually have no difficulty identifying species and timber stands on the ground because these objects are viewed from a familiar angle. Identification on photos is more

difficult because objects are seen from an unfamiliar vantage point somewhere above these objects. Thus the interpreter must translate what he sees on the photo into what he would see on the ground at the point in question. To do this he must draw on his general forestry training, his general knowledge of the area, and the correlations of species with site, slope, and topographic conditions within the area to be typed.

Characteristics Useful for Mapping

Some characteristics which will aid in the classification of forest land are discussed in the following paragraphs:

Stand-Size Class

Stand-size is probably the most important single item to be seen on photos, since it is most directly related to the volume of the stand. Height and crown diameter are the two factors visible on photos that determine the stand-size classification. Three classifications are recognized: seedling-sapling, pole and sawtimber. One of the more readily discernible features visible on photos is stand-size differences.

Sawtimber: Height is the most obvious clue. The taller the stand, particularly in relation to other adjacent stands, the greater the probability that the stand is sawtimber. Crown size is generally related to DBH; the larger the crown, the larger the DBH. Generally, larger crowns coupled with increased height indicates sawtimber.

Poletimber: Height shorter than sawtimber, but greater than seedling-sapling stands. Crown size is smaller than sawtimber, but larger than seedling-sapling stands. Texture generally finer than sawtimber for a given species, but coarser than seedling-sapling stands.

Seedling-Saplings: Height is shortest, crown size the smallest, texture is the finest. Differentiation between poles and seedling-sapling stands will be most often based on height and texture, since little or no difference may be visible in crown size. Some seedling-sapling stands may not resolve on 1:20,000 photos.

Density

In using density guides to determine stand stocking, it is necessary to compare the number of crowns on a given area with the number of blackened squares on the guide, or the number of circles in the guide. Although a stand may appear very dense and black, much of the denseness may be caused by black shadows filling the space between crowns. Therefore the interpreter must look at the visible crowns and not be too greatly influenced by the dark shadows between the trees. The black squares or circles on the density guide represent only crowns and do not include

crown shadow. Photos taken at high noon will have little shadow and stands may appear to be less dense than those seen on photos taken either earlier or later in the day with a correspondingly greater amount of shadow. In uneven aged stands, the taller trees may partially or totally obscure the smaller trees with their shadows. The photo interpreter should attempt to look through or into these shadows to see if other crowns do exist below these larger trees.

Species Identification:

The following are general aids in identification of species in sawtimber stands 50% or more pure.

Species	Texture	Tone	Crown Appearance
White pine	Feathery	Light	Broom top
Ponderosa pine	Very coarse	Medium dark	Rough
Larch	Medium fine	Light	Pinchusion appearance
Alpine fir	Medium	Very dark	Sharp
Douglas fir	Coarse	Medium dark	Rough
Spruce	Medium coarse	Dark	Sharp
Lodgepole pine	Medium coarse	Medium light	
Limber pine	Very coarse	Medium light	Ragged
Cedar	Coarse	Medium dark	Shiny, rounded
Hemlock	Medium Coarse	Medium dark	

Interpretation Procedures

Generally the best approach in delineating forest strata is to work from the obvious to the difficult. General procedure should be as follows:

1. Eliminate areas not covered by this inventory by eliminating photos and marking the starting point of the effective area. Counties will also have to be separated. This will be accomplished prior to the fieldmen receiving the photos.
2. Delineate effective area as described in this manual. It is recommended that this **not** be considered a separate job, but be accomplished each day for the photos which are to be typed that day. This will necessitate starting at one corner of a county and working away from it.
3. Separate the nonforest land from the forest land and label the nonforest areas with the proper symbols.
4. Separate the forest land into commercial and noncommercial and label the non-commercial strata.
5. Separate hardwoods from conifers down to the minimum strata areas.

6. Break remaining commercial forest land into appropriate strata. Start with stand-size differences and then further refine the strata by delineating differences in crown density within a given stand-size class. Proceed from the most obvious to the more difficult. Some caution should be used in this step because some differences plainly visible on the photo may not need to be delineated under our mapping system. For example, a definite and obvious stand height difference may be visible on the photo. Both stands are composed of the same species and have the same crown density. But one is a 30-foot pole stand and the other is a 50-foot pole stand. In this case the two stands would be mapped as a single stratum because they both fall into the same stand-size class.

Any type smaller than the minimum area of 5 or 10 acres will be included in the nearest related adjoining type. Hardwoods will be included with hardwoods and conifers with conifers, regardless of stand-size or density. Otherwise relationships will be based on stand-size class, density and species, in that order. For example, a 4-acre area of conifer sawtimber located between a coniferpole stand and a conifer seedling-sapling stand would be too small to be delineated as a type in itself. Therefore the sawtimber stand would be included with the pole stand, since sawtimber is more closely related to a pole stand than it is to a seedling-sapling stand.

In all cases where small types are included with adjacent types, consider the effect of such inclusions upon the composition of the resulting area. For example, a number of small meadows scattered throughout a large area of well-stocked timber may lower the stocking from "well" to "medium."

Ignore type stringers less than 120 feet in width. In applying either minimum width or minimum acreage controls to mapping, attempt to delineate the natural shape as well as size of area. With aerial photos many type boundaries are relatively easy to outline for the production of a map which has the natural character and pattern of the country. It is poor practice to produce, by careless mapping, type boundaries that are mainly geometric figures, e.g., rectangles or circles.

Types should be outlined within effective areas only, but assure that each type line which stops at an effective area line properly continues on the next plot. Use red Weber's pigment ink on the face of the photo for both type lines and symbols. Be sure that areas are labeled, leaving no blanks and no cases of two or more differing labels for the same area as delineated on the photo or on the adjoining photo. Check each photo for these items as it is completed. Date and initial photo on back upon completion of the various steps.

Orient all symbols to read with the same edge of the photo up, generally the north edge. Show map symbols in the following sequence: Forest type, Stand-size class, Density, e. g., D 9 WM, LP 8 W, S 9 PP, NC.

If necessary to make corrections on the mapped photos, use moist absorbent cotton to remove the Weber's ink. Rub lightly in all cases so as to not scratch or remove the emulsion. If the photos are difficult to ink, wipe the emulsion side with carbon tetrachloride to clean the surface. Be careful not to obliterate the effective area lines.

Use the photo interpretation aids provided for estimating minimum area and density classes. These are:

Crown Density Scale—Percent Crown Cover Forest Survey,
Central States Forest Experiment Station

Timber Survey Aid No. 1—Units of measurement at 1:20,000
Scale; Pacific Northwest Forest and Range Experiment Sta-
tion

Forest Survey Stereograms
Forest Survey, Intermountain Forest and Range Experiment
Station

Tie type lines and designations across effective area boundaries between photos as you go along. Check each flight line for these items as it is completed.

Field Checks:

The interpreter will delineate and label that of which he is positive prior to going into the field. Every type in which there can be a question in type or size-class identification will be checked on the ground. In areas of frequent type changes or stand-size variation, a 100% ground check may be necessary. In all cases the photo interpreter will certify by initials and date of classification that he considers the delineation of areas to be acceptably accurate.

Classification as to Accessibility and Topography will be accomplished during this field check. For procedures see page 18.

Effective Area Delineation

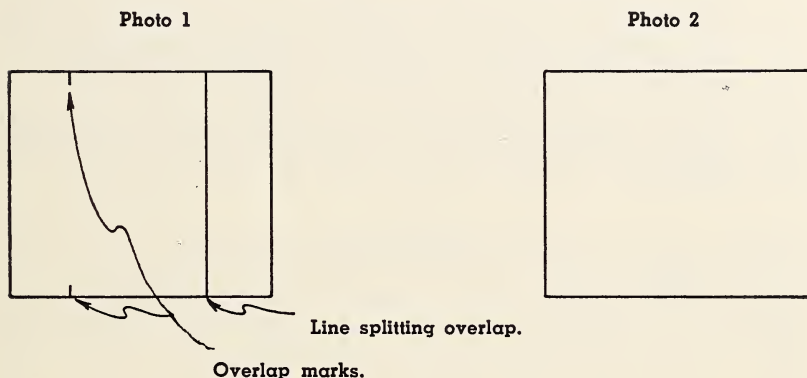
There is a large amount of endlap and side lap in the aerial photos which results in duplication. In preparing photographs for type mapping, the so-called effective area is delineated on the photographs. In 1:20,000 photography, the effective area is about two square miles or from 1,200 to 1,600 acres; in 1:15,840 photography, the effective area is near one square mile or 720 acres, while for 1:12,000 scale, it is near 400 acres. If the following procedure is followed correctly, the effective areas will be roughly rectangular and each area will have two straight sides and two irregular sides. Following is the procedure to use in delineating effective areas:

1. All photos should be placed in flight lines, each line beginning at the same side of the area covered by the photos. That is, if pictures have been flown in a north-south direc-

tion, flight lines will be arranged so that all photos run from south to north or vice versa, but not having some lines run from north to south and others south to north. This applies regardless of the direction of flight. For effective area work, travel from north to south or from west to east is preferable. Nevertheless, such matters as photo availability in the various counties will control this. In the following examples the flight lines run east and west.

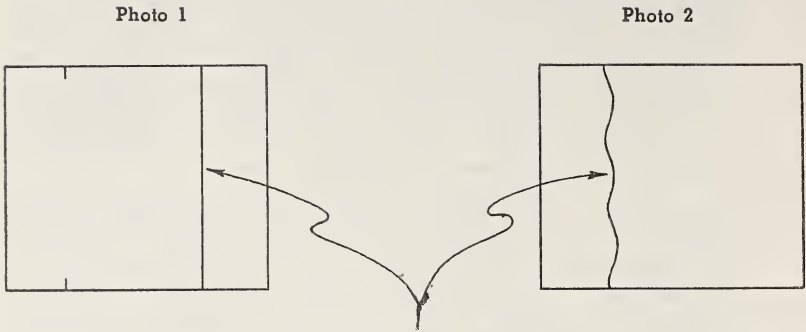
2. Start with a line of photos on the edge of the area. Use the first two pictures in the line—or the last two, if preferred; determine where Photo No. 2 overlaps Photo No. 1 by visual inspection. Mark the overlap by a small mark near each edge of the photo. Since endlap is roughly 60 percent, Photo No. 2 will lap photo No. 1, in 9-inch photos, about $5\frac{1}{2}$ to 6 inches. The small dashes on Photo No. 1 in the sketch in Step 3 indicate this overlap, which has actually been determined by visual inspection. (Figure 1.)
3. Split, on Photo No. 1, the amount of overlap and draw a straight line across the photo. Use green india ink. This line is the solid line in the following sketch: (Figure 1.)

Figure 1



4. Using the mirror stereoscope, transfer the line drawn in step 3 stereoscopically from Photo No. 1 to Photo No. 2. This line will generally appear crooked on Photo No. 2 because of displacement or distortion: (Figure 2.)

Figure 2

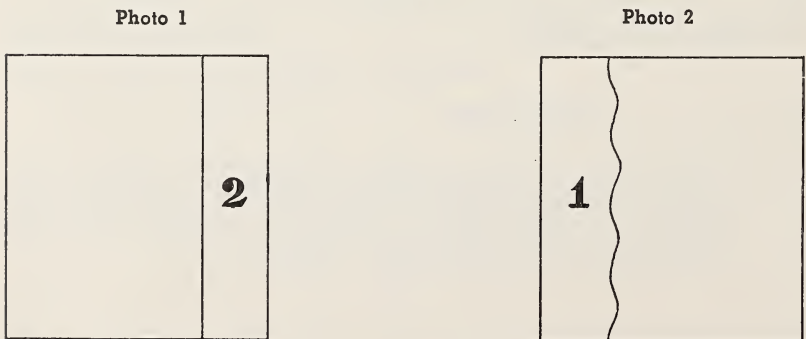


Same line—that is, the line is drawn
over the identical course or objects in each photo.

In transferring the line stereoscopically, mark the stereo image of the line on Photo No. 2 by using dashes along ridge top, mid-slope, and creek or river bottoms. Join the dashes freehand to form the line.

5. Visually inspect the two photos to assure yourself that the line on Photo No. 2 is identical to the line on Photo No. 1 with respect to location. A slight rotation of the stereoscope about the flight line can cause the line to be displaced by a considerable amount. Make any necessary corrections.
6. Number the lines drawn in the above step. Use the photo number and place the photo number in the marginal space; Figure 3.

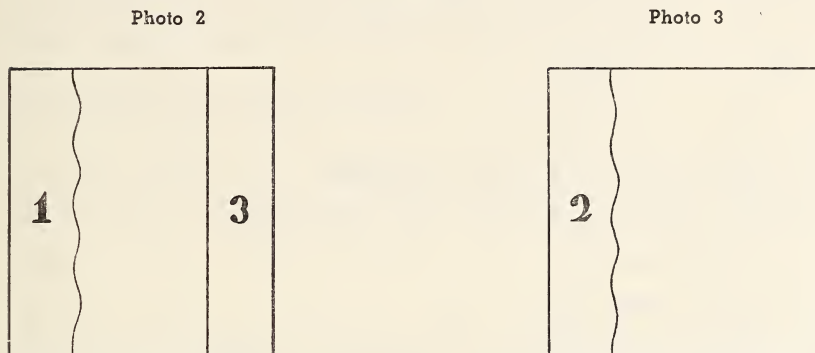
Figure 3



7. Place Photo No. 1 face down to your left. Shift Photo No. 2 to your left, take the next photo (Photo 3) from the flight on your right. Place it in the position Photo No. 2 occupied. (Figure 4.)

8. Determine how much Photo No. 2 overlaps Photo No. 3, split the overlap and draw a line on Photo No. 2, splitting the overlap.

Figure 4



9. Transfer the line on Photo No. 2 to Photo No. 3 stereoscopically and number the lines as before, visually checking the transferred line.
10. There are now two lines on Photo No. 2, a straight line on the right side, and a crooked line on the left. The entire procedure should be continued through each flight line, as you need the photo for type delineation. When a line is finished, the first photo in the line should have just one line on it; this line will be a straight one. The last photo will have only one line also; this line will be a crooked line, however.
11. When endlap has been completed for the photos needed for type delineation, sidelap is done. Sidelap requires a little more care and is somewhat more difficult than endlap. Starting with two lines of photos—call them Line 1 and Line 2—that is, the first two adjacent lines on one side or the other of the group of photo lines. Again the photos should be in the order mentioned in Step 1. Place the lines of photos in their proper orientation. For clarity, let us assume that Line 1 is the northern-most line of photos, and Line 2 is immediately to the south of Line 1.
12. Taking the top photo in Line 1 and the photo in Line 2 which is adjacent, divide sidelap between the two photographs.
13. Draw in the solid line on Line 1, transfer this line stereoscopically to adjacent photographs in Line 2 as was done for endlap as in Step 9. (Figure 5.)

Figure 5

Photo 2—Line 1

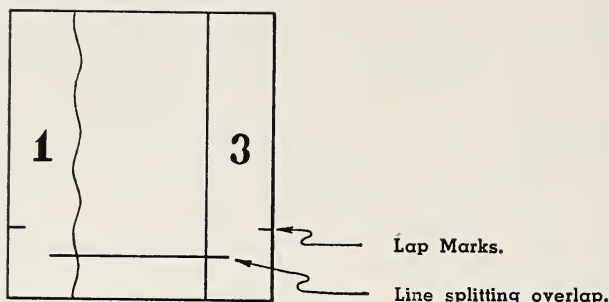
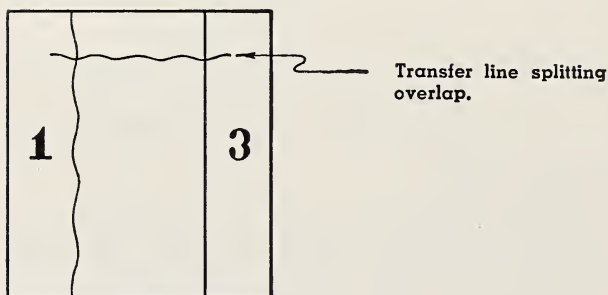


Photo 2—Line 2



Delineating effective areas eliminates all duplicate coverage; if done correctly no area will be eliminated—likewise, no area will be duplicated within the effective area lines.

In some cases where the photographs have been sectionized; and the area is relatively flat or rolling topography, it is possible to use sections or parts of sections as boundaries of effective areas. If this method of delineating effective area is used, it is desirable to extend the type lines at least one-half inch beyond the effective area line to assure coverage of the section desired. This system would probably be used only in an area of checkerboard ownerships.

Field Checking Areas Delineated by Other Agencies

When available, work performed by other agencies will be utilized; provided a random or systematic sample check meets the qualifications established in "Accuracy Check, Area Determination Phase" as appears in this manual. Any deviations due to differences in symbols, or minimum area will be corrected by supplemental work prior to the checking procedures.

If this delineation work done by other agencies is acceptable, supplemental field work will be required to determine access and topography classification for the area (See page 18, for proce-

dures). No other agency collects this information. If it has been determined that photographs are not necessary for forest type delineation they will not be ordered solely for access and topography classification. Nevertheless, it may be possible to borrow the photographs to accomplish this classification as no marks would be required on the photos. If it is not possible to borrow these photos, a map alone may be used.

Pin-Pointing Land Survey Location

As an aid in transcribing photo detail to the base map, section corners, quarter corners, and line crossings will be pin pointed on the photos at the time that the field check of the forest typing is made; unless instructed otherwise. The procedure will be as follows:

This location of corners and lines must be done with a high degree of accuracy (within 40 feet of the correct position on 1:20,000 photographs). If by visual and stereoscopic comparisons of field and photo detail, the corner or point location can be positively made, the point will be pricked through the emulsion with a fine needle point. The hole is not necessarily punched completely through the photo but must merely be visible when holding the photo to the light. Locations will be inked (with Posts Black Drawing ink or equal) on the front of the photo as follows:

7 | 8
—○—
18 | 17

Pin-pointed Section Corners—.2 inch circle with cross legs .2 inch long, .2 inch from corner, section number .2 inch high.

8
—○—
17

Pin-pointed Quarter Corners—.2 inch circle with lines .2 inch long, .2 inch from corner section numbers .2 inch high.

7
—○—
18

Line Crossing—circle .2 inch in diameter, lines .2 inch long, .1 inch from crossing.

8 | 9
— —
17 | 16

Approximate location of found corner (no pin point)—Cross legs .2 inch long, .2 inch from approximate corner location.

Cross legs in all cases should be in cardinal directions similar to lines they represent.

All locations should be inked on the photo where the effective area covers the location. On the reverse side of the photo next to the location, the interpreter will date and initial location and note the source, e.g., field, transferred from USFS photo, etc.

Procedure for Areas with Activity Since Photography:

The most recent photography available will be used in every case possible. A maximum age of photography has been set by the Board of Equalization and older photography will not be used; nevertheless areas will be discovered during the field check where logging, road construction, fire, etc. has occurred since the photographs were taken.

These areas will require special attention by the interpreter. The photos will only show the land as it appeared the day the pictures were taken. Where practical, it is the intention of this inventory to acquire information as of the date the photos are delineated. This special problem will have to be solved by the interpreter while in the field on the area in question.

All types that are **not** as shown on the photographs will be typed according to the existing stand, with the added notation of "A" under the type symbol e.g. $\frac{P\ 9\ MP}{A}$ to indicate activity since photography which will eliminate any question of interpretation error later in the inventory process.

The type lines for this change of forest type will not show on the photograph. The field man will have to employ every aid he can determine to designate the boundaries as they now exist. Some of the possible methods to accomplish this include:

1. Determine the area of activity on the ground and tie it to the photograph, basing the identification of points both on the photo and on the ground, e.g., an area between two existing roads has been completely selectively logged since the picture was taken. On the photo it appears to be P 9 WW on the ground it is P 9 MP adjust by typing this area between the roads as $\frac{P\ 9\ MP}{A}$
2. Map size and shape of logged area by pacing and compass, or use of a plotting instrument of equivalent accuracy such as the Rheinhart Ready Mapper or the Coordinate Calculator, and transfer to photo at the proper scale.
3. High vantage points often give a better view of the area than when right in it, especially when determining the extent of the activity.
4. Local inquiry may give some information, but usually the time required to orient a layman on the photo far exceeds the meager information which may be obtained.
5. Combinations of these methods and perhaps others will most likely have to be used to obtain the desired information.

TRANSCRIBING PROCEDURES

Accuracy Technique and Equipment

It is of paramount importance that detail transferred from the photographs to the forest type mapbase be done with the greatest care and accuracy possible with the equipment used.

The Kail radial line plotter is used only on areas that have rough terrain and little planimetric control showing on the photograph. This sketch made to the scale of two photographs is transferred to the base map with the Overhead Projector.

All other areas will be detailed directly from the photograph to the base map with the over-head projector.

Overhead Projector Procedure

(Focalmatic Desk Projector)

Description

This instrument projects the image of any opaque drawing to a desk or working surface at any scale between .33x to 2.0x. Automatic focusing through a 162mm f/4.5 lens produces an image well within acceptable limits of accuracy.

Adjustment

Little or no adjustment of this instrument is required. Only when the thickness of paper used on the working surface is changed, an appreciable amount of adjustment is required.

Operation

a. **General:** The photograph is placed surface side against the pressure plate and held in place with spring tension on the cover plate. Enlargement or reduction in the scale of the image is secured by raising or lowering the lens by use of a crank which also automatically places the image in proper focus. Best results are obtained by working in a darkened room.

b. **Base Orientation:** Adjust the base map so that all planimetric features in the image pass through the base map features radially from the photo center. When the features do not pass through radially mark, on the base, the photo center (with a dot and a circle thus—). This orientation should be maintained as various scale changes are made because displacements in a single vertical aerial photograph are radial from points at or near the principal point.

c. **Transfer of Detail:** The accuracy of detail transfer depends greatly upon the skill of the machine operator.

Photo detail usable as control (when the same detail appears on the base) grouped in order of preference is as follows:

Roads.

Telephone lines.

Transmission lines.

Pipe lines.

Cutting lines, if substantiated by a pin-pointed corner.

Lakes.

Arable land.

Swamps.

Small streams.

Rivers.

Ridge lines.

Draw detail (type lines) onto the base by setting the scale of the image in the proximity of the above planimetric features. Draw this detail with a firm 3H pencil line. Adjust the scale of the image as it changes due to changes in elevation between the various planimetric controls. Few, if any, scale changes are necessary in relatively flat terrain.

Check of Transcribing

A check of all adjacent mapping will be made. Assure that all required detail is transferred and that type stratum labels are properly copied.

When a base map has been thoroughly checked, the type lines and labels are inked using a No. 0 or No. 1 rapidograph pen and Post's black Drawing Ink.

Kail Plotter Procedure

The radial planimetric plotter was designed to provide a simple, accurate and inexpensive means of transferring the planimetric detail of the aerial photographs directly on to the map base or to map to the scale of the first two photos in a flight. In this inventory it will be used to overcome the exaggerated distortion found in rough terrain or where there is little planimetric control, which makes the Overhead Projector or single photo image detail transfer difficult and inaccurate.

Detailed instructions for operation of the Kail radial planimetric plotter are on file in the Office of the State Forester. Operation of this equipment is detailed and will be utilized by a few persons only.

AREA CALCULATION PHASE

General

Area calculation of the information collected in this inventory is a complicated process because each and every area has been classified into different categories in three separate classifications, which are:

1. Ownership
2. Forest type strata
3. Accessibility and Topography

In other words, it is possible to have as many different areas as there are owners **times** the number of forest strata **times** five for the classes of accessibility and topography. This does not include the number of areas in a county identical to another. Limitations in scale of base map and photography are such that the judgment of the area calculator must be accepted in adjusting minor discrepancies that arise in combining the above mentioned classifications. Certain areas of large or small ownerships, or large or small areas of varying forest types, or variations in accessibility and topography or lack of such variations may cause special problems, which in the judgment of the operator necessitates deviation from the following procedures. Such deviations will be allowed, provided the same degree of accuracy may be obtained.

Preparation of Base Maps

The type strata on the base map are colored to facilitate computation by setting out the type areas, especially large, rambling areas. Each timber species should be represented by a certain color or set of colors. The important thing is to be able to readily determine the extent of the type so as to prevent crossing type lines in area determination.

The accessibility and topography classes are transcribed to the ownership base map furnished by the county. These classes will be represented by the following color scheme:

Class	Venus No. 200 Pencil
Favorable	Yellow
Average	Orange
Difficult	Green
Impractical	Pink
Unproductive	Red

Procedures

Place the Ownership-Access and topography base map over the Forest Type map on a light-table. Type stratum for each ownership-access and topography class are then numbered starting from a convenient point, i.e. upper left hand corner of ownership, and following through on what seems to be a logical consecutive order. Areas are then determined by use of an M K area calculator, a dot grid, or a planimeter. For large areas the M K electric calculator is faster, for small type areas the dot grid is best. As areas for each numbered type strata-access class are determined they are recorded on the map and on the Area Record Form, see page 37. If extremely small areas develop when combining these classifications, adjust access and topography classification only, if such adjustment appears logical. All areas will be carried to the nearest whole acre. The expanded acres of all type strata will be balanced to the total acres of tract ownership.

INVENTORY OF PRIVATE FOREST LAND AREA RECORD FORM

Sheet.....of.....

County:..... Sub-Division:.....

Ownership Unit:..... Section:.....

Total Legal Acreage:..... Township:.....

Range:.....

Map No.	Map Symbol of Strata	Access & Topography Total Grade in Class	Initial Count	Conversion Factor	Acreage
	NF & "	Favorable—3 & 4 Average—5, 6 & 7 Difficult—8 & 9 Impractical—10 & 11 Unproductive—See Classification			
	NC	Unproductive			
	Total				

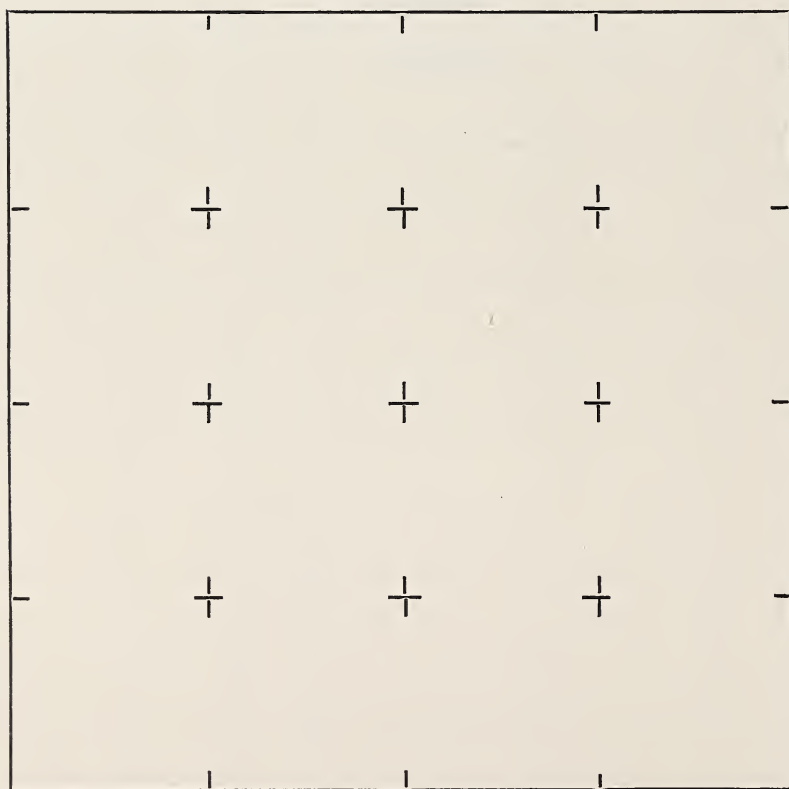
**INVENTORY OF PRIVATE FOREST LAND
AREA RECORD MAP**

County:..... Sub-Division:.....

Ownership Unit:..... Section:.....

Total Legal Acreage:..... Township:.....

Scale:..... Range:.....



ACCURACY CHECK OF AREA DETERMINATION PHASE

Accuracy of the work done in this phase will be controlled by two separate methods. They may be separately described as (1) qualitative and (2) quantitative.

Employing qualified personnel, giving sufficient training on project procedures, and close supervision will prevent much of the human error that arises in this work. This qualitative check will be continuous and informal in nature. It will be employed to prevent errors before they occur. This will be conducted by the State Forester.

Quantitative control of these procedures will be conducted on a random or systematic sampling basis for the work performed by the personnel. It will consist of a comparison of the final acreages obtained by two separate and independent performances by different interpreters, of all the procedures involving the sample area. This will require slightly over twice the normal costs for the sample area, but will assure that the information is as reliable as the method will allow. In each county or area to be checked 5% of the total area will be selected, either randomly or systematically, to be the sample check area.

Acceptable limits for variance present a special problem in obtaining a balance between a fair and just valuation and the cost of this valuation determination. It appears that the best standard for setting this limit of variation would be the total value of the forest land for the individual owner. It appears to be possible to set a relatively high standard of consistency when measured on this basis; within 5% of the total value may be possible to maintain. This limit, however, is impossible to determine solely in the area determination phase.

Permanent record will be made of each quantitative accuracy check. This report will be filed at the Office of the State Forester.

Variations can be corrected so that work would be acceptable.

